CHAPTER 7
SITE CHARACTERIZATION

7.1 Introduction.

a. When planning geophysical investigations for MEC at current and former military installations, it is necessary to determine the limits of the area to be investigated. Military installations are often extremely large and not all areas are likely to have buried MEC. The ASR, historical aerial photographs, range-control records, facility engineering and master planning documents, personnel interviews, and other pertinent documents will be carefully evaluated in order to locate evidence of how, when and where munitions might have been used at a project property.

7.2. MRS Footprint Identification.

a. Footprint Analysis is a logical process of selecting areas for further site characterization activities that are likely to contain MEC. The Footprint Analysis is conducted in the planning phases of a project, as it is important to gain customer, stakeholder, and regulatory consensus early on in order to achieve site-closeout.

b. Footprint Analysis is the set of tools, techniques, and processes that are used to narrow and focus MEC investigations to those areas that have at least some evidence of potential MEC impact. Footprint analysis can also be used to help identify potential MC sampling locations. Figure 7-1 shows the workflow steps that are typically used in conducting a Footprint Analysis. The workflow presented here is intended to identify the procedures that can be performed at any type of project property. Footprint Analysis is very site-specific, however, and the workflow should be modified based on the unique site conditions and circumstances encountered at each project property as well as to the specific goals and objectives of each project.

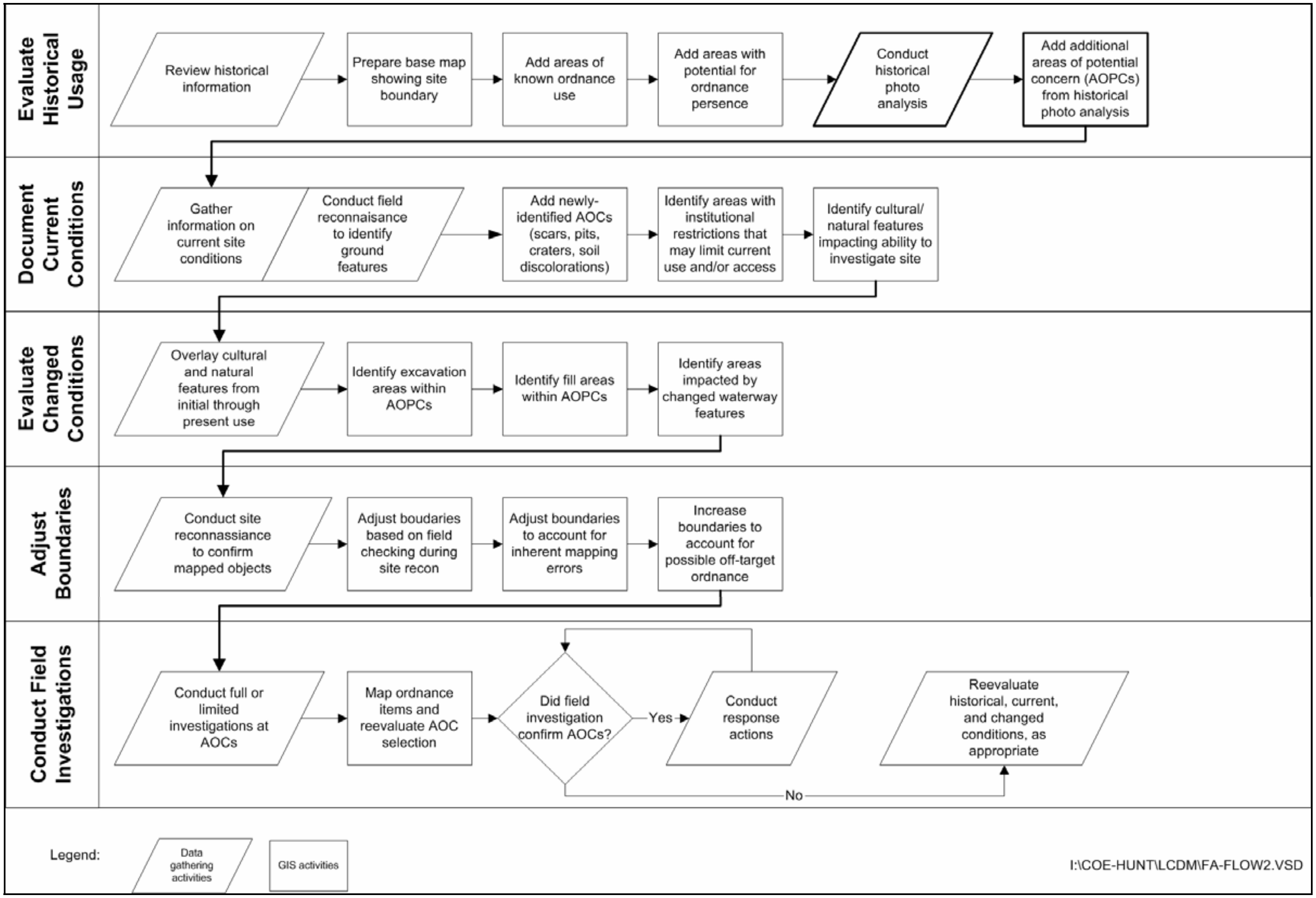

Figure 7-1. Footprint Analysis Workflow.

c. "Footprint" refers to the geographical extent of areas to be investigated for MEC and, during later phases of a project, subjected to response actions. The purpose of the Footprint Analysis is to evaluate past and present site conditions and activities in an attempt to define, to the greatest practicable extent, the boundaries of this footprint. Footprint analysis can also be used to help identify potential MC sampling locations. An excessively large footprint can impose unneeded costs for additional investigation and response, as well as pose an inconvenience to landowners. An erroneously small footprint, on the other hand, can increase the public risk posed by undetected MEC. The major steps in conducting a Footprint Analysis include:

(1) Evaluate Historical Usage.

(2) Document Current Conditions.

(3) Evaluate Changed Conditions.

(4) Adjust Boundaries.

(5) Conduct Field Investigations.

d. Evaluate Historical Usage.

(1) The Footprint Analysis begins with an evaluation of historical information regarding the past uses of the project property. Historical usage includes the period during which the project property was used for DOD activities, as well as subsequent uses until the present. Only project property usage is evaluated during this stage of the workflow; physical conditions of the project property are evaluated during a later stage.

(2) All available historical information regarding uses of the project property should be compiled and reviewed in order to locate potential areas of MEC use. This data may include historical maps, ordnance usage records, newspaper articles, and interviews with former project property personnel.

(3) Historical information may be documented in an ASR, which may also identify areas of potential concern (AOPC) for further investigation. However, the ASR should not be relied upon as the sole source of historical information. Neither should the AOPCs be construed as representing the final footprint for field investigations. The ASR should only be viewed as a starting point for further historical research.

(4) Prepare Base Map Showing MRS Boundary.

(a) The MRS boundary will usually be known and documented even before the historical information review is conducted. However, the boundary should be verified through historical records. The historical review may reveal that the current MRS boundary was incorrectly defined, that mapping errors occurred and that the true boundary is misrepresented on existing maps, or that other reasons exist for modifying the boundary.

(b) Once a good degree of confidence is reached regarding the MRS boundary, a base map should be prepared with the boundary clearly identified. This base map will form the basis of the subsequent GIS activities that will be conducted in the remaining Footprint Analysis tasks. This base map may be constructed using aerial photographs, satellite images, or U.S. Geological Survey (USGS) Topographic Quad Maps as a background.

(5) Add Areas of Known Military Munitions Use. Areas of known military munitions use, or those areas in which there is a high degree of confidence that military munitions were used, should be added to the base map. These will usually be areas where authoritative documentation identifies specific areas of military munitions use, such as firing fans, bombing targets, MEC storage areas, disposal pits, etc. Authoritative documentation could include range maps and other historical records from the former military facility that governed the project property. The level of confidence in the use of military munitions in these areas should be indicated on the map. The identified AOPCs could be buffered to show the accuracy of the boundary (e.g., if the accuracy of the boundary is known to be +/- 20 feet, then show a 20 foot buffer around the AOPC).

(6) Add Areas with Potential for MEC Presence. Unconfirmed accounts of military munitions use in certain areas will often be found during the historical information review. Ambiguous documents, unsubstantiated narratives from interviewees, and other information from dubious sources may point to areas potentially impacted by MEC. This information should be thoroughly reviewed and, if not discounted, should be identified on the map. These areas should be identified differently to indicate the low level of confidence in the information. This may include attribution in the GIS to indicate the source, and a larger buffer to indicate the lower confidence in the spatial accuracy.

(7) Conduct Historical Photo Analysis. An historical photo analysis can assist in confirming suspected areas of ordnance use, substantiating questionable information on unconfirmed areas of ordnance use, and in identifying AOPCs. Guidance on conducting historical photo analyses is outside the scope of this document.

(8) Add Additional AOPCs from Historical Photo Analysis. Additional AOPCs that were identified in the historical photo analysis, if one was conducted, should be added to the base map. Such AOPCs may be identified by ground scars, areas of soil discoloration, or other features that indicate possible past military munitions use or disposal at the MRS. Secondary military munitions-related features such as historical firing fans can also be added to the database. Such features assist in refining the model and improving the confidence in the results.

(9) Photogrammetry and Digitizing.

(a) When using photogrammetry products such as aerial photos, it is important to determine which DQOs are being fulfilled. This determination will help decide which type of product to use. For example, black and white historical aerial photographs may be sufficient to delineate suspicious areas such as ground scars, even though color aerial photography may also be available. The black & white aerial photos should be used for this task as they provide the required data elements and are less expensive than color.

(b) Once the data type is determined, it is important to consider how processing will affect the accuracy. When performing digitization and/or orthorectification the root mean square (RMS) error should be considered as a guide to determining the total accuracy of the layer. Or, if receiving information digitally, such as USGS digital orthophoto quarter-quads (DOQQs), the stated absolute accuracy is +/– 23 feet. USGS Topographic Quadrangle maps are +/– 40 feet. Also, it is important to bear in mind that these numbers represent accuracy at a scale of 1:24,000. When presenting data at a larger or smaller scale, this will need to be noted.

e. Document Current Conditions.

(1) After the historical use has been thoroughly reviewed and AOPCs have been marked on the map to show potential MEC use and disposal areas, current conditions should be documented. Documentation of the current conditions will aid in planning for the field investigations and response actions.

(2) Gather Information on Current Site Conditions. Necessary information concerning current site conditions includes natural features such as topography, water features, and ground cover. Cultural features such as roads and highways, buildings, fences and other developments should also be shown. Institutional information, such as land use, demographics, and access controls, may also play an important part in Footprint Analysis as it pertains to conducting field investigations and implementing response actions.

(3) Conduct a Site Visit to Identify Ground Features. It is usually appropriate to conduct a site visit to identify any additional AOPCs that were not revealed by other investigation methods.

(4) Add Newly-Identified AOPCs (scars, pits, craters, soil discolorations). During the site visit, additional AOPCs may be identified. These could include ground scars, soil discoloration, and evidence of disposal pits, firing fans, or other military munitions use. Any AOPCs that were not identified as a result of the historical information review should be placed on the map and further evaluated.

(5) At this stage in the Footprint Analysis, another iteration of earlier steps may need to be conducted in order to evaluate AOPCs identified during the site visit. Information that may have been previously overlooked or discounted may indicate whether the new AOPCs should be included in the MRS footprint.

(6) Identify Areas with Institutional Restrictions that May Limit Current Use and/or Access. Institutional restrictions may restrict the ability to conduct field investigations or response actions. Access restrictions and land use restrictions are examples of institutional restrictions that would impact further actions. Although institutional restrictions would not change the actual footprint, the restricted areas should be identified on the map.

(7) Identify Cultural/Natural Features Impacting Ability to Investigate the MRS. As with institutional restrictions, cultural and natural features may restrict the ability to conduct field investigations. These features may also impact the need for response actions; therefore, these areas may be removed from the MRS footprint. Buildings, roadways, and parking lots are examples of cultural features that could be removed from the footprint. Rivers, lakes, and wetlands are natural features that may be removed from the footprint. Natural features, however, must be evaluated much more carefully, as investigation and response in these areas may still be necessary. Archaeological features may also influence the footprint.

f. Evaluate Changed Conditions.

(1) The evaluation of historical and current conditions will usually identify the vast majority of AOPCs that define the MRS footprint. However, an evaluation should be made of how the changes have been made over time.

(2) Overlay Cultural and Natural Features from Initial Through Present Use. Time series mapping may be conducted by overlaying cultural and natural features from all periods for which information is available. An evaluation of how these features have changed over time may help to further define the MRS footprint.

(3) Identify Excavation Areas Within AOPCs. A time comparison of topographic and other features may reveal the presence of areas that have been excavated from within the AOPCs. Excavation areas can also be identified from historical photo analysis and historical records. If the depth of excavation can be determined with a high degree of certainty, these areas may be able to be removed from the MRS footprint if the depth of excavation exceeds the maximum depths at which MEC could be expected. For firing fans and bombing targets, this would be the maximum penetration depth of military munitions that might have been fired or dropped at the AOPC. For other areas, such as disposal pits and burn areas, the depths would be dependent on the specific circumstances surrounding the past uses of the AOPC.

(4) Identify Fill Areas Within AOPCs. Fill areas may also be identified as noted above. Two concerns exist with fill areas: the placement of MEC along with the fill material, and the

burying of existing MEC beneath the fill material. If the fill material was excavated from an AOPC, MEC could have possibly been moved along with the fill. In this case, the filled area may need to be included in the MRS footprint. If clean fill was placed in an AOPC, then the fill depth must be evaluated for its impact on the ability to conduct, and need for, field investigations and response actions.

(5) Identify Areas Impacted by Changed Waterway Features. The time comparison should also include an evaluation of changes in water features, as appropriate. Meandering streams, drained wetlands, and new or drained lakes are examples of water features that could either increase or decrease the MRS footprint.

g. Adjust Boundaries.

(1) Introduction. The purpose of the earlier steps in the Footprint Analysis was to add areas to and remove areas from the MRS footprint. In this step, the locations and existence of mapped MRS features are checked and the footprint is adjusted to account for any inaccuracies.

(2) Conduct a Site Visit to Confirm Mapped Objects.

(a) After AOPCs have been selected through the evaluation of historical and current conditions, a site visit may be necessary to confirm the locations and existence of the features that have been identified. A handheld GPS receiver is useful in confirming the approximate locations of mapped features.

(b) A site visit can be used to evaluate features identified in the historical photo analysis, such as ground scars and burial pits, and to help increase the confidence of the data obtained from the historical documents and interviews.

(3) Adjust Boundaries Based on Field Checking During Site Visit. The site visit may reveal that mapped locations vary from actual locations. Historical facility maps often show planned locations, and actual locations may vary. Fence lines may be mapped as approximations and the actual fence lines vary due to topography and ground cover. Likewise, planned target fans may have been adjusted to account for site-specific conditions, and as-built maps were never prepared. When actual locations and boundaries can be accurately surveyed and mapped, the footprint should be adjusted accordingly.

(4) Adjust Boundaries to Account for Inherent Mapping Errors. As ground features are placed on the map during the Footprint Analysis, there will be inherent inaccuracies in the locations. This inaccuracy results from variations in scale and the precision of accurately identifying points on maps and aerial photos. These variations should be evaluated, and variance areas should be identified on the footprint map.

(5) Increase Boundaries to Account for Possible Off-Target Military Munitions. Firing fans and bombing targets should be evaluated to identify adjacent areas where off-target military munitions may have landed. This evaluation should be based on the types of military munitions used, how the military munitions were fired or dropped, and the directions in which the military munitions were fired. The site visit discussed above may also identify off-target areas where shrapnel or impact effects are noted outside the identified firing fans and bombing targets. The MRS footprint should be adjusted as necessary to show the off-target areas.

h. Conduct Field Investigations. The MRS footprint that is developed from the preceding steps can be used as a basis for planning focused field investigations. The information derived from the field investigations should be used to reevaluate the footprint and update the CSM. In an iterative process, one or more of the preceding steps may need to be conducted again in order to refine the footprint. Geophysical surveys are frequently used to provide data on the footprint by gathering new field information and are usually implemented as part of the site characterization process.

7.3 Sectorization.

a. Once the review of historical documents has been accomplished, the project property will be sectorized. Sectorization is the process by which large, non-homogenous areas of a military installation are subdivided into smaller, more homogenous areas. When defining sectors, the following factors will be considered:

(1) Former military use.

(2) Anticipated MEC type.

(3) Anticipated MEC distribution.

(4) Terrain and vegetation.

(5) Current land use.

(6) Natural and cultural boundaries.

b. Obviously, it is not possible to define a sector that is completely uniform and homogenous throughout. However, the goal is to define sectors such that any necessary future munitions response actions can be applied to the entire sector. It will be noted that sectorization is an active process. As the project continues and more data is collected, it is likely that sector boundaries will need to be modified to reflect actual site conditions. The selection of the sectors should be in accordance with the current understanding of the project property as defined in the CSM. Geophysical surveying only attempts to characterize the MEC sources that contribute to the risk, however, issues such as what the likelihood of people encountering MEC as defined in the CSM should also be taken into account when deciding on how to sectorize the project property.

7-4. Geophysical Site Characterization Strategies. Geophysical site characterization strategies are used to define the extent and nature of the MEC impact at AOPCs such as ranges, bombing targets, or burial pits. Characterizing known AOPCs will determine the location of the geophysical sampling using prior knowledge. In many cases historical information will provide general locations and usages of ranges and other training areas and these historical locations can be used to locate geophysical sampling.

a. Sampling Methods – Sampling methods include transects, meandering path, and specific grid locations. Each of these geophysical survey techniques is discussed in greater detail below:

(1) Transects. Geophysical investigation transects are one approach used to characterize AOPCs. Transects are also a good approach to determine the boundaries of MEC-impacted areas of a sector or to locate an impact area or to locate AOI's whose exact location and extent is not known. The transects should be oriented perpendicular to the long axis of the AOPC in order to maximize the chances of defining the AOPC. Transects are best utilized at project properties with easy terrain and vegetation. In areas of rough terrain and increased vegetation, the positional inaccuracies of the method will likely lead to significant increases of cost in the reacquisition task. The transects follow a semi-fixed path with defined start and end points. An example of transect surveying for determining the extent of a range is shown in -Figure 7-2.

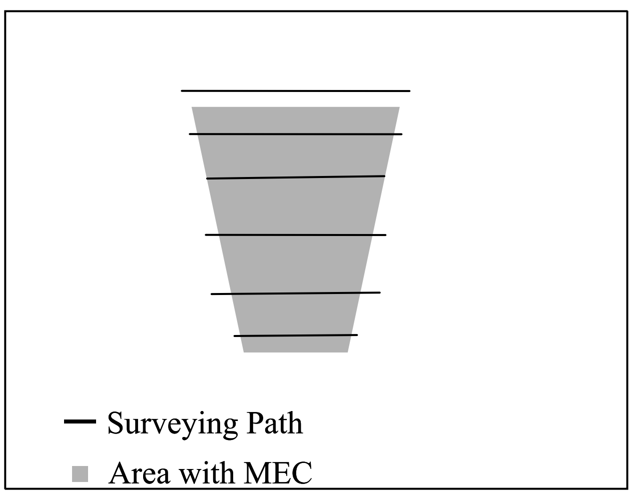

Figure 7-2. Transect Surveying for a known AOPC

(2) Meandering Path Surveying. Meandering path surveying is a process where a geophysical investigation instrument is integrated with a navigation instrument, usually differential GPS that links positional data with the geophysical readings. Then, a geophysical team “meanders” randomly throughout a location, until the total area geophysically mapped equals the area that would have been required if surveying grids were used. Afterwards, the geophysical data is analyzed, anomalies are located and then excavated and evaluated. If the purpose of the meandering path survey is to estimate the number of anomalies in a given area, then the method can offer large cost savings on project properties with difficult vegetation and terrain since vegetation removal costs are virtually eliminated and surveying costs are greatly reduced. However, if the sampling plan requires that the anomalies be reacquired and intrusively investigated, then the method becomes much more expensive because of poor positional accuracy that is associated with this method. The poor positional accuracy can significantly increase the cost of the reacquisition task of the project. An example of meandering path surveying is shown in Figure 7-3.

(3) Fixed Grid Surveying. Fixed grid surveying is used when the location of the AOPC is known and the objective is to determine the amount and type of MEC impact. One or more fixed grids could be located within a range to determine the type of ammunition used and/or the condition of the MEC impact. An example of fixed grid surveying is shown in Figure 7-4.

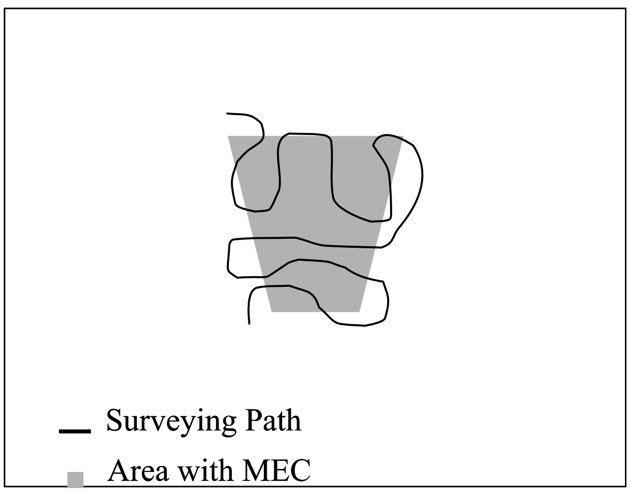

Figure 7-3. Meandering Path Surveying for a known AOPC

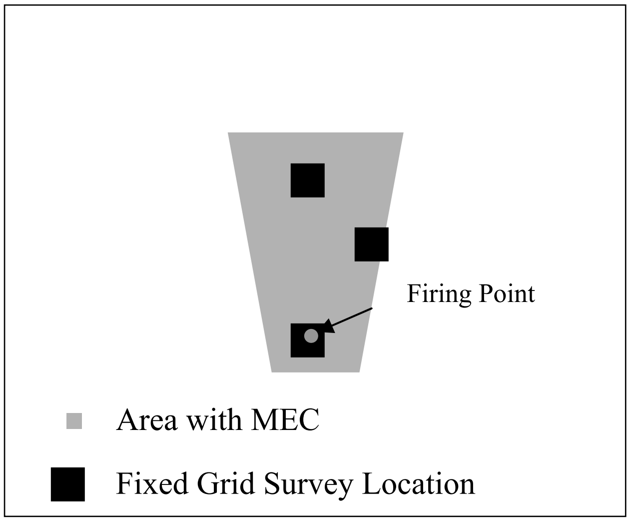

Figure 7-4. Fixed Grid Surveying for a known AOPC

7-5. Sampling Methods.

a. When geophysically characterizing a sector, an initial decision will be made regarding where the geophysical investigations will occur. Basically, there are two choices: either investigate the entire sector, or sample a representative portion of the sector and infer the results across the whole. On relatively small sectors it can be efficient in terms of cost, schedule, and environmental impact to geophysically map the entire area. However, larger project properties can present significant cost, schedule, access and environmental impact challenges that preclude 100 percent surveying. In these cases, the sampling program design must incorporate the CSM and project objectives established during the TPP process. It is often appropriate to establish minimum and maximum distances between sampling locations (i. e transects or grids) to achieve a distribution that efficiently characterizes the site for the possible sources described in the CSM. Various surveying methodologies and situations where they may be used are discussed below.

(1) 100 Percent Surveying. Complete geophysical mapping is a good approach for small project properties. At such locations the mobilization/demobilization and other fixed costs can be relatively high when compared to the actual mapping costs. In these cases, the most cost-effective approach might be to map the entire project property. Such an approach is particularly recommended for project properties smaller than about 20 acres.

(2) Biased Surveying. The locations for biased surveying are selected based on historical information to determine where the geophysical surveys will be performed. This type of surveying will only be considered when the objectives of the investigation are not of a

statistical nature. Generally, conclusions drawn from biased surveying apply only to the individual survey areas and aggregation may result in severe bias and erroneous conclusions.

(3) Probability Surveying.

(a) When the study objectives involve estimation or decision making, some form of probability surveying is required. Probability surveying is surveying where every member of the target population has a known probability of being included in the surveying. This does not preclude the use of an expert's knowledge of the project property in designing a probability-based surveying plan; however, valid statistical inferences require that the plan incorporate some form of randomization in selecting the surveying locations. An efficient probability surveying design is one that uses all available existing information to stratify the region and set appropriate probabilities of selection. For example, probability surveying can take into consideration prior knowledge of areas with higher potential for MEC presence (e.g., targets) by weighting such areas more heavily in the sample selection and data analysis.

(b) Probability surveying can be of various types, but in some way they all make use of randomization, which allows valid probability statements to be made about the quality of estimates that are derived from the resultant data. USACE has developed a statistical process, known as UXO Calculator to determine the amount of geophysical mapping necessary to characterize a homogenous sector of an MRA. For a discussion of this methodology, refer to Chapter 10 of this manual. The statistical approach is designed to characterize "dispersed" MEC such as occurs at impact areas, bomb target areas, kick-out from open burn/open detonation (OB/OD) operations, dispersal from munitions magazine explosions, and similar activities. It is not designed to statistically characterize activities that do not have random patterns, such as MEC intentionally buried, purposely hidden contraband munitions, and similar activities. Other methods such as the Visual Site Planner are currently being developed. The USAESCH website should be checked for tools that may have come available.

(c) The amount of surveying necessary within a sector is determined by USAESCH's geophysical surveying protocols. The larger the sector, the smaller a percentage of surveying is necessary as long as the location is homogeneous with respect to the likelihood of ordnance occurrence. UXO Calculator is a statistical tool that can be used to estimate the percentage of surveying needed in addition to best professional judgment. The amount of sampling is also based on the objectives of the project. When UXO Calculator is used, site specific assumptions need to be considered to determine appropriate surveying percentages. The two main assumptions that are used with UXO Calculator are that the MEC has been deposited randomly and there is a uniform probability of MEC occurrence over the entire MRS. Table 7-1 indicates the approximate amount of surveying (random plus directed) that can be anticipated using the UXO Calculator.

(d) Table 7-1 only provides rough guidance of how much area is to be surveyed, and it must be stressed the table reflects recommended coverage based on the assumptions explained above. Not all CSMs will fit those assumptions. More detailed information is obtainable on the USAESCH website. The final selection of the amount of area to be geophysically investigated depends on the project's objectives (for example if the objective is to define the extent/location of Area of Interest (AOI) or to determine if unknown AOI exists within sector.) The sampling methods and the amount of geophysical surveying to be performed should be defined in the TPP and take into account the current CSM.

Table 7-1. Typical Geophysical Surveying Requirements

Sector Size, Acres	Basic Minimum Area Investigated	Recommended Minimum Area Investigated
< 50	5.0%	7.5%
51 –100	3.0%	4.5%
101 – 150	2.0%	3.0 %
151 – 1000	1.0%	1.5%
> 1000	0.5%	0.75%

(e) It should be remembered that mobilization/ demobilization and other fixed costs can be relatively high when compared to total geophysical investigation costs at small project properties. Therefore, at small project properties it is often more cost-effective to geophysically investigate the entire location, rather than use statistical surveying.

7-6. Excavation.

a. After a grid, or other area, has been geophysically mapped, multiple "anomalies" are likely to have been located. For mag & flag projects, these anomalies will be marked as flags at the location of each subsurface anomaly. For projects where digital geophysical methods are used, the geophysicist will pick and evaluate anomalies with the help of analytical software. In either case, qualified UXO personnel will excavate the anomalies in order to determine if the anomaly represents MEC, or some other feature. On many grids, the number of anomalies will be manageable and all will be excavated in order to characterize the grid. However, at some project properties, particularly those within impact areas, the number of anomalies may range from several dozen to several thousand anomalies per acre, most of which will be small metallic fragments. When this occurs, statistical sampling of the grid for site characterization may be necessary.

(1) 100 Percent Excavation. When there are, on average, fewer than approximately 50 anomalies per acre, all anomalies will be excavated and evaluated.

(2) Statistical. When there are, on average, more than 50 anomalies per acre then it may be necessary to statistically sample the anomalies. Statistical sampling should be applied such that the results of the sampling will meet the data needs and the DQOs of the characterization project. The method for statistically sampling the anomalies should take into the account the objectives of the characterization effort. Different sampling strategies should be employed if the objective is to confirm the presence of MEC or the number of MEC related items. Furthermore, if the statistical sampling is based on anomaly characteristics (amplitude or size) then some sampling of anomalies which don't meet the criteria should be sampled to validate the selection process.

7-7. Data Interpretation, Resectorization, and Decision Making.

a. After a project property undergoes an analysis of historical information, is sectorized, sampling grids placed, geophysical sampling performed, and anomalies identified, excavated and evaluated, it is necessary to carefully interpret all the data and determine if project objectives have been met. Original sector boundaries may need to be changed, new sectors may need to be added, and data gaps may exist that will be filled prior to subsequent decisions being made.

b. The geophysical data and evaluations are usually incorporated into a larger study (e.g., EE/CA, RI/FS, Site Characterization) and involve project stakeholders making decisions regarding future work to be performed.

7-8. Geophysical Investigation Planning Tools.

a. Characterization Planning. In this sub-section we first explain how project needs and project objectives are developed and then we describe the various elements to be included in a GIP to document and explain the decisions made by the PDT in developing the characterization strategy. This subsection also provides detailed considerations for such planning elements as: survey coverage, geophysical system accessibility, MEC characteristics, terrain and vegetation characteristics, cultural features, and anomaly decision criteria. The contents of this chapter assume site characterization is designed in coordination with the needs and objectives of the MRS Conceptual Site Model.

b. Define Project Needs and Objectives. This sub-section discusses the PDT's role in developing specific geophysical data needs and objectives to characterize a munitions response site. Topics will generally be limited to statements describing strategies to characterize different areas of concern or areas of potential concern. Here the PDT will state the purpose of each planned survey in each AOC/AOPC, how much surveying needs to be done in each area, and what data and information is needed. This sub-section also explains the need for all PDT data users to understand the reasoning in how geophysical systems and geophysical data will be used, and how it will factor in subsequent site-characterization tasks such as hazard assessment and remedial/removal cost estimating. Most MEC characterization goals and decisions are based on geophysical investigations. PDT input in the design and implementation of geophysical field work is strongly recommended.

c. Key elements of the characterization objectives must be specified before undertaking geophysical planning because significant cost savings can be achieved by tailoring the geophysical investigation plan to the characterization needs. The following lists most characterization needs that affect geophysical investigation planning:

(1) Based on the CSM, what is the smallest semi-minor axis or smallest footprint of the target/impact area likely to be for each AOC/AOPC?

(2) What is the minimum MEC diameter on a project-specific, site-specific or even range-specific basis?

(3) How much geophysical data is needed within the footprint?

(a) Only a single grid or transect need pass within any hypothetical footprint. Objective is to detect evidence of MEC contamination through investigating all anomalies detected, which would include MEC and MEC debris (such as frag)

(b) At least _X_ grids or transects need pass within any hypothetical footprint. Objective is to detect evidence of MEC contamination through investigating only anomalies that could be MEC, small potential frag anomalies will not be investigated.

(c) At least _X_ grids or transects need pass within any hypothetical footprint. Objective is to define boundaries of suspected MEC contaminated areas by calculating anomaly rates per grid or per linear transect length. Biased grid locations will be used to characterize contamination based on transect data.

(4) How critical is it that each anomaly be positively resolved?

(a) The hazard assessment requires each anomaly detected be positively resolved

(b) The hazard assessment requires each anomaly having MEC characteristics be positively resolved

(c) Each anomaly must be positively resolved in each grid or transect or AOC/AOPC until the first MEC is recovered.

(d) The hazard assessment requires certain percentages of each priority of prioritized anomalies be positively resolved.

(e) Transect anomalies will not be resolved. Only all anomalies in grids must be positively resolved, grid locations will be determined based on transect anomaly densities.

(5) To maximize site coverage and minimize project cost, what is the closest distance any two transects or grids should have between them? [This distance may require supporting statistical calculations]

(6) To maximize the likelihood of finding a suspected target or impact area, what is the greatest distance any two transects or grids should have between them? [This distance may require supporting statistical calculations]

(7) To maximize field efficiency and minimize project cost, what are the minimum and maximum grid sizes that will support both the characterization needs and project budget constraints?

(8) How accurate must grid centroids and/or transect control points be reported?

(a) Grid centroids and/or transect control points must be reported to a high order accuracy

(b) Grid centroids and/or transect control points can be reported to a low order accuracy, distances between grid corners and/or transect control points need to be known to a higher degree of accuracy

(9) Do decisions require all detected anomalies to be dug or will a subset of anomalies provide sufficient characterization data? (Can anomaly discrimination be used?)

(a) All anomalies meeting MEC criteria must be dug

(b) Anomaly dig priorities will be developed and various percentages of each priority, as defined by the PDT, must be dug

(10) Do total numbers of anomalies need to be reported? If yes, will "binning" anomaly counts according to geophysical characteristics be needed?

(a) All detected anomalies must be reported

(b) All detected anomalies, grouped by category or priority, must be reported

(c) Only those anomalies listed on dig sheets need be reported (this is rare)

(11) Will high-precision position reporting suffice for project needs or will geophysical data require high-accuracy position reporting as well?

(a) Measurement positions within grids or along transects must be reported with high precisions, high accuracies are not required because reacquisition procedures are not affected by position accuracy.

(b) Measurement positions within grids or along transects must be reported with high accuracies because of the reacquisition procedures being used.

(12) Will the project schedule support a multi-phase field effort (e.g. transect mapping/anomaly rate calculations followed by biased grid sampling?)

(a) Yes, a multi phase approach is supported so that digging resources can be tailored to maximize efficiency

(b) No, all work must be performed concurrently to minimize disruption to the community

(c) No, all required work is defined and no efficiencies will be gained through a phased approach.

(13) Will reacquisition procedures be affected by the passage of time after data collection?

(a) No. Digging will occur soon after data collection and reacquisition procedures will not be affected

(b) No. Digging will occur at some later time and reacquisition procedures will not require recovery of grid markers and/or transect markers

(c) Yes. Digging will occur at some later time and reacquisition procedures require recovery of low order accuracy grid markers and/or transect markers

(14) What are the vegetation conditions and are there constraints on vegetation removal (cost, habitat, endangered species, etc.)?

(a) Vegetation removal is constrained and/or costly. The locations and sizes of grids and/or transects needs to be flexible, some characterization objectives may not be met due to these constraints

(b) Vegetation removal is not constrained but is costly. The locations and sizes of grids and/or transects needs to be flexible, some characterization objectives may not be met due to these constraints

(15) What are the cultural and/or access constraints?

(a) Cultural and/or access constraints will impede production rates, some characterization objectives may not be met due to these constraints

d. Specify the Characterization Decision Strategy

(1) The term characterization decision strategy is used to define how various decisions will be made during field operations such that project objectives are met while at the same time allowing flexibility in resource management and scheduling. Specifically, characterization decision strategies should be centered around exactly how much data is needed to support a given decision in a given AOC or AOPC, and specifically what that data must include. Decision strategies must factor for the goals and needs detailed above, as appropriate.

(2) The PDT must decide what findings will constitute delineating an area as contaminated with MEC and what findings will support a determination of no contamination indicated. To address the former, finding a single UXO, elevated concentrations of MEC fragments, or even simply increased densities of geophysical anomalies, could be used to delineate an area as either contaminated with MEC or suspected of being contaminated with MEC. Once such a determination is made, all subsequent data collected in that area should be focused to answer more specific questions about the types of MEC present, the lateral extents and concentrations of contamination and the vertical extents and concentrations of contamination.

(3) To address what is needed to support a determination of no contamination indicated, a combination of statistical tools, geophysical sampling patterns and decision logic should be developed. Decision logic should include all reasonable sources of evidence. Listed below are some possible sources, the PDT must determine which are basic sources, which are optimal, and which are excessive, and identify other sources as appropriate.

(a) Known/confirmed features from the CSM

(b) Geophysical anomaly densities per acre or anomaly rates per linear transect length

(c) Dig results and percentages of anomalies investigated

(d) Reconnaissance results

(e) Visual observations

(f) Lidar

(g) Multispectral or hyperspectral analysis (to include visible spectrum digital orthophotography)

(h) Topography maps/DEMs

(4) Once all sources of information are defined, the PDT must then identify the assumptions for each source used and this information must be conveyed to all team members. One tool for conveying this information is a decision diagram, illustrated below. This diagram presents a simplified decision logic that uses geophysical data, dig results, visual observations and GIS information to explain how decisions will be derived during field work. This diagram also shows how geophysical system needs are defined and tailored to maximize efficiency and minimize cost.

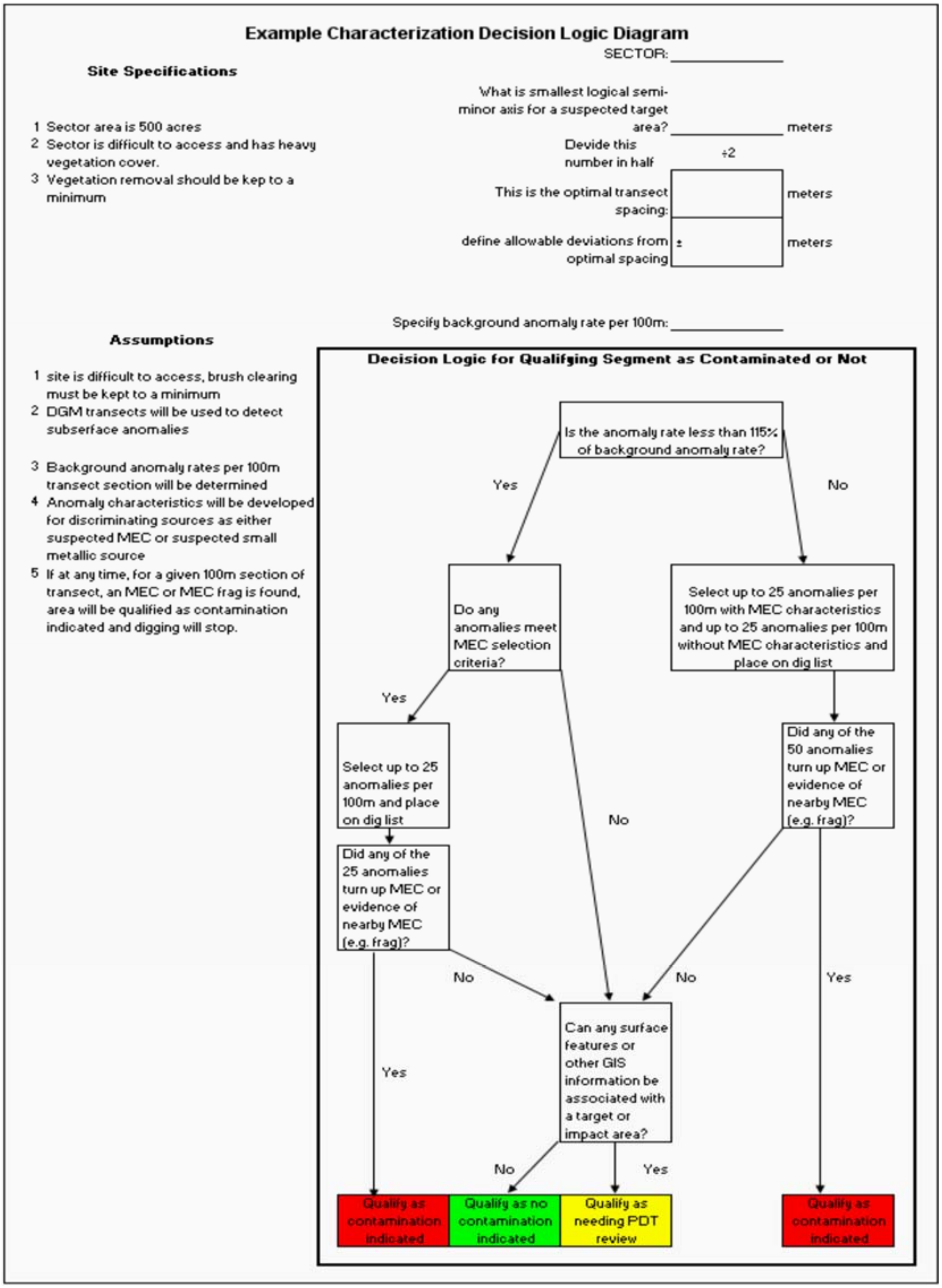

Figure 7-5. Example characterization project decision diagram.